FORMING LOW RESISTIVITY P-TYPE GALLIUM NITRIDE

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ABSTRACT OF THE DISCLOSURE

One embodiment of a process that forms low resistivity III-V nitride (e.g., GaN) p-type layers removes all sources of hydrogen (typically NH_3) in the epitaxial growth chamber during the post growth cool-down process. By eliminating sources of hydrogen during the cool-down process, any additional passivation of the acceptor impurities (e.g., Mg) by hydrogen atoms during cool-down is avoided. After the cool-down process, the wafer is annealed at a relatively low temperature (e.g., below 625°C) to remove nearly all of the hydrogen from the Mg-doped layers. The anneal can take place at a low temperature since the diffusivity of H in the p-type GaN layers is much higher than in i-type GaN layers. If the p-type layers are used in an LED, since the low temperature anneal does not degrade the GaN layers' crystallinity, the intensity of the LED's emitted light is not decreased by the anneal process. In other embodiments, the Mg-doped GaN layers are capped with an n-type GaN layer or any n-type semiconductor layer during epitaxial growth, prior to cool-down, to block the in-diffusion of H during the cool-down period. The n-type cap is then removed prior to the low-temperature anneal step. In other embodiments, the Mg-doped GaN layers are made slightly p-type after the cool-down but prior to annealing. This may be done using various processes.